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A New Microstructural Imaging Approach through EBSD Pattern Region of Interest Analysis

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The requirements of a highly tilted sample and a well-polished surface for optimal EBSD pattern collection can make traditional SEM imaging challenging. With a tilted sample, SEM SE and BSE detectors are often in non-optimal positions for electron detection. For many materials, the polished surfaces produce weak contrast with SE imaging. Traditionally placed BSE detectors must be used with care, as a highly tilted sample can risk collision as the sample size and region of interest increases.

Typically SE and BSE detectors are supplemented with a Forward Scatter Detector (FSD) system during EBSD analysis [1]. One or more solid-state diodes are positioned around the perimeter of the EBSD phosphor screen to detect relative changes in scattered electron intensity. Amplification circuitry is then used to convert the detected signals into a useable analog video signal which is in turn converted into a digital imaging signal. The requirement of this amplification hardware in practice limits the number of detectors which can be simultaneously imaged.

A new imaging technique termed PRIAS (Pattern Region of Interest Analysis System) has been developed which synergistically uses the EBSD camera and phosphor screen for both EBSD pattern collection and as an array of positional electron intensity detectors for faster imaging of microstructural information through variations of scattered electron intensity. This approach as currently implemented provides up to 25 positional imaging detectors. Detector size and position are determined by assigning regions of interest (ROIs) locations across the phosphor screen. Figure 1 shows a set of images where the detectors were sized and positioned to both enhance and suppress crystallographic orientation contrast from a TiAl alloy sample. This positional capability can also be used for Transmission-EBSD (T-EBSD) analysis, where the distribution of scattered electrons across the EBSD phosphor screen changes significantly relative to standard EBSD patterns. Figure 2 shows an image where an RGB coloring scheme was used with 6 selected ROIs to enhance contrast across the thickness variations of a thin Al foil used for T-EBSD. As illustrated here, weighted arithmetic processing and coloring is available with all detectors simultaneously.

There are currently 3 approaches to PRIAS imaging. The first takes advantage of current high-speed EBSD detectors by using large pixel binning values to produce fast camera frame rates with low resolution images not suitable for traditional EBSD pattern analysis but containing useful information for microstructural imaging. This approach enables faster imaging without needing full EBSD pattern analysis. The second defines ROIs to be sampled during standard EBSD mapping and generates imaging data from each simultaneously with traditional EBSD orientation, compositional, and phase information. The third allows for ROI analysis of saved EBSD patterns. This approach allows for iterative positioning and analysis of ROIs. Both the second and third approaches allow for PRIAS imaging signals to be directly correlated with standard EBSD measurements. This correlation could be utilized

for expanding orientation contrast specific imaging in the method of Electron Contrast Channeling Imaging (ECCI).

References:

[1] A.P. Day and T.E Quested, Journal of Microscopy 195 (1999), pp. 186-196.

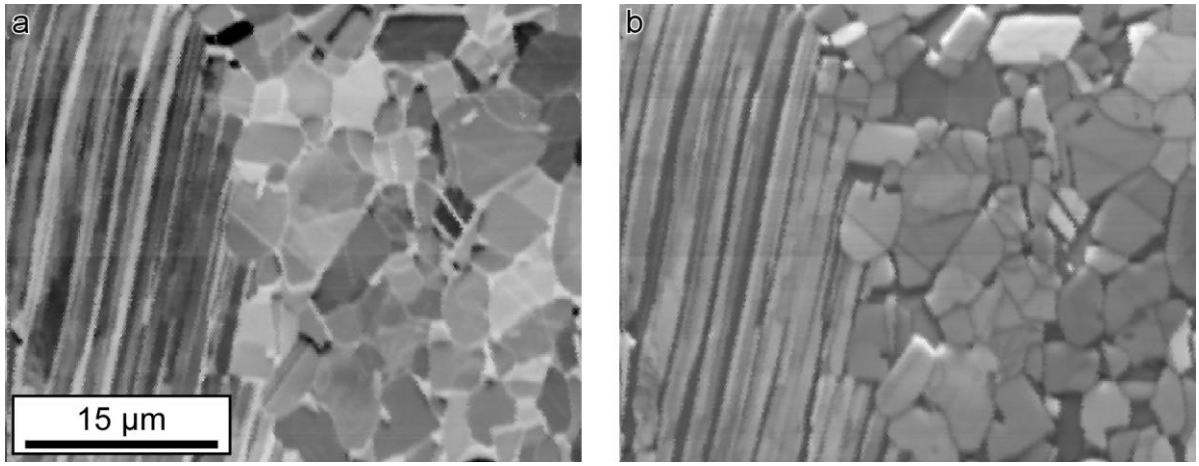

Figure 1. PRIAS images with ROIs positioned and sized to (a) enhance and (b) suppress orientation contrast from a TiAl alloy.

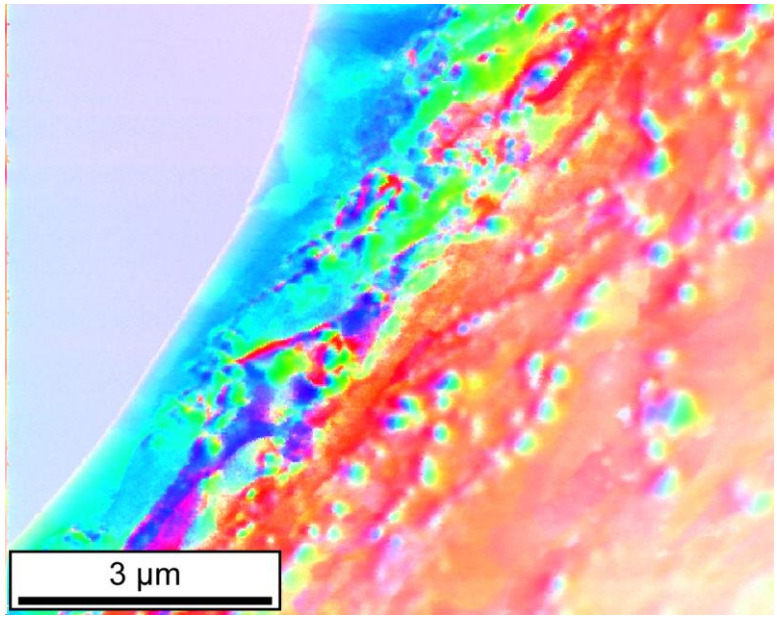

Figure 2. PRIAS image from Al T-EBSD sample using RGB color mixing with 6 selected ROIs to maximize microstructural contrasts across foil thickness.

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